Sunflower Seed Production

Manitoba's Newest Agricultural Industry

ERIC D. PUTT, AGRONOMIST

CO-OP. VEGETABLE OILS LIMITED
ALTONA, MANITOBA, CANADA

JANUARY, 1949 (2nd printing January 1950)
(REVISED EDITION)

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INTRODUCTION

Sunflowers have been grown on a garden plot scale in Southern Manitoba for two or three generations, particularly by farmers of Mennonite origin. Most of this seed has been used for human consumption. During the war the acute shortage of vegetable oils and resulting program by the government for increased acreages of oil-bearing seeds led to expansion of the sunflower crop to a commercial scale. A logical demand following this development was the erection of an oil extraction plant. Such a plant, owned and operated by Co-operative Vegetable Oils Limited, commenced extraction of sunflower seed oil in March, 1946.

These undertakings have caused an extensive interest in the sunflower crop and its possibilities, from outside sources. Requests for information concerning seed production, sunflower varieties, value of the oil and other products of the extraction plant have been received from all sections of the continent. Unfortunately not all stories circulating have been found correct. This publication is an answer to the many requests for information. It is presented by an organization which has been vitally interested in the industry from the outset and is thus qualified to speak for it. Because the crop is new, rapid changes are occurring. The information given here is the most recent available. However, the reader is advised to keep in touch with the publishers for changing developments. It is expected that leaflets will follow this bulletin providing new information as it arises.

FOREWORD

Demand for this publication has been much greater than expected. The total supply of over 2,000 copies of the 1949 printing was completely distributed by November. This 1950 printing is identical to the 1949 printing except for minor revisions in the section "Plant Description."

No major developments or changes in methods of production were made in 1949. Cultural tests conducted gave results similar to those reported from the previous year's work. The stripper type of attachment as described in the "harvesting" section was again used very successfully. The only change of significance was the universal adoption of a 9-inch pan, spaced 12 inches centre to centre,, instead of the 15-inch pans, spaced 18 inches centre to centre, as described in this publication.

Acreage of sunflowers increased to 60,000 in 1949. Average yield was about 500 pounds per acre compared with 800 pounds in 1948. This lower yield was due mainly to drought during the summer and unusual storm damage to mature fields just before harvest. Price to the grower is expected to reach 4 to 5 cents per pound. With a yield of 500 pounds per acre and this price the crop is still one of the most profitable available to the farmers. There is every indication for a continuing increase in the acreage of sunflowers in future years.

—ERIC D. PUTT.

Jan. 1, 1950

THE FIELD CROP

HISTORY OF THE CROP

The sunflower is a native plant of the Americas, being found in the wild state from Nebraska southward. It is the state flower of Kansas. Indians utilized the plant as a source of food. It was introduced into Europe in the sixteenth century and spread over that continent, with the largest acreage being grown in Russia. During the late nineteenth century it was re-introduced into America as a cultivated plant. The Mennonite variety is the result of seeds brought to Canada by Russian emigrants.

At present the crop is grown on a commercial scale in several countries with a notable increase being recorded during the war years. Argentina for example has stepped up production to over one million tons of seed for the 1945-46 crop. Russia reported a crop of 2.7 million tons in 1941. Other countries producing on a small scale include Uruguay, Algeria, China, France, India, Palestine, Great Britain, United States and several of the central European countries. (9)*

The crop was first grown on a commercial scale in Canada in 1943 as a result of government promotion for increased production of oil bearing seeds. In that year 4,000 to 5,000 acres were grown, producing about five million pounds of seed. This acreage was evenly divided between Saskatchewan and Manitoba. In succeeding years the production has shifted almost entirely to Southern Manitoba and increased to 28,000 acres, yielding an estimated 22.5 million pounds of seed in 1948. Approximately 20,000 acres were also grown in 1948 in North Dakota and Minnesota.

VARIETIES

At present four varieties are suitable for growing in Manitoba. These are in order of desirability: Advance first generation, "Advance second generation," Sunrise and Mennonite. Comparative yields and other data for these varieties are presented in Table 1.

The Advance first generation is a top cross hybrid developed by the Dominion Experimental Farms system. The female parent in this variety is an inbred of desirable characteristics selected out of Mennonite stock. The male or pollen parent is the variety Sunrise. The Advance variety as shown in Table 1 is a high yielding variety. It has uniform single head type with strong stem and fair resistance to bird damage and is about five days earlier in maturity than the Sunrise variety. It also has a desirable high oil content.

Sunrise variety was an introduction from Russia by the Division of Forage Plants, Ottawa, Ontario, in 1936. It was recognized as a desirable type of sunflower at Saskatoon in 1938 and subsequently increased and distributed to farmers for commercial production in 1943. It is a uniform dwarf type of high oil content with slight branching from the base of the plant. It has small seed which does not shatter easily. However, this small seed makes it more susceptible to bird damage than the other varieties. Its chief disadvantages

*Figures in brackets are reference numbers.

Table 1—Yields and agronomic data of four varieties of sunflowers. Weights in pounds, measurements inches.

Variety	Seed yield per acre		Plant height inches		Seed weight per bushel		Percentage oil whole seed	
	1947*	1948	1947	1948	1947	1948	1947	1948
Mennonite	2,397	1,368	63.5	66.3	25.56	25.25	26.62	27.64
Sunrise	1,293	827	56.7	58.2	29.50	30.26	30.14	33.32
Advance first generation	2,098	1,380	55.1	62.6	26.79	28.20	30.61	35.57
Advance first generation		1,265		61.0		28.21		34.95
Advance second generation	1,874	884	56.1	47.5	27.44	27.18	30.94	33.12
Advance second generation		1,086		59.4		27.44		33.72
L. S. D. 5% point	282	71			1.36	.97	1.63	1.09
L. S. D. 1% point		92				1.31		1.47

*Prospective growers should keep in mind these plot yields for 1947 are exceptionally high. The results should only be considered for relative yielding ability of the varieties.

are rather late maturity and low yield in comparison with Mennonite and Advance. Its chief importance in the industry for the future is as a parent of the Advance first generation hybrid.

"Advance second generation," as the name implies, is the seed resulting from planting of the first generation Advance hybrid. Besides lower yield than the first generation it lacks the uniformity of first generation and shatters more. Also the 1948 results in Table 1 show it to be significantly lower in oil content and weight per bushel than first generation. It is recommended for seeding over the Sunrise and Mennonite varieties only when the first generation seed is not available.

Mennonite, as has been previously stated, is the name applied to the material introduced to Canada from Russia by the Dutch Mennonites emigrating from that country. It has been grown ever since in small plots by these farmers for their own consumption. Consciously or otherwise each farmer has selected his own type so that a wide range now exists in this material. Generally speaking the variety is four to five feet in height. Plant type varies from single stem to many branches and from strong to very weak stems. The variety tends to shatter its seed readily, thus causing loss in yield and an undesirable amount of volunteering in the succeeding crop. Though of high yield its large seed has low oil content, bringing a lower price than the other varieties from the commercial crushers. Very limited amounts are taken by the specialty trade for roasting purposes. Its chief desirable feature is its earliness, being the earliest of the varieties named. For the plant breeder its wide range of types also offers a desirable medium for selection, especially for early maturing strains.

HYBRID SEED PRODUCTION

As the Advance first generation is a top cross hybrid securing its yielding ability from the hybrid vigour, sowing of new seed each year is essential. As has been mentioned this hybrid is made up of an inbred and the Sunrise variety. For seed production these two parents are planted in fields isolated from all other kinds of sunflower by at least one-half mile. They are planted in alternate groups of two rows each, usually designated as 2x2 crossing blocks. As the Sunrise parent is later maturing than the inbred it must be planted about one week earlier than the inbred to bring the two parents into flower at the same time. Another common procedure is to plant both parents at the same date but fertilize the Sunrise at a rate of approximately 30 pounds of 11-48-0 per acre. The fertilizer will then stimulate the Sunrise to flower at the same time as the inbred. Natural crossing occurs in these fields chiefly due to insects as pollen carriers. For reasons not clearly understood yet, the percentage of crosses is greater on the inbred parent. As a result only the seed from the inbred is harvested as the hybrid seed. That from the Sunrise is sold for commercial crushing purposes.

The Plant Products Division of the Dominion Department of Agriculture with the Canadian Seed Growers' Association offers field inspection and registration for the seed grown in crossing blocks. Two field inspections are made, one at flowering time and one shortly before harvest. To pass field inspection the crop must be rogued two or three times to remove offtypes. All strongly branching and purple type plants as well as any other obvious

off types must be removed before flowering from both parents and white seeded plants taken from the inbred parent before harvest. To qualify for registration the cleaned seed sample must also pass seed inspection. The foundation parent stocks for production of this seed are sold in Canada by the Morden Experimental Station only. For seed and full details prospective growers are advised to write or contact this institution. In areas where the concentration of sunflowers is not great there is good opportunity for the production of this seed as the one-half mile isolation can easily be obtained.

As mentioned above the two parents are planted in groups of two rows each. Groups of four rows have also been used. The question of which method is better has been investigated during the last two years. Of thirteen growers producing Advance seed in 1946 seven used a 2x2 and six a 4x4 type block. Checking these fields in 1947 revealed that the seven 2x2's gave an average crossing percentage of 66 and the six 4x4's an average of 56 per cent. A similar check in 1948 showed five 2x2's and seven 4x4's giving crossing percentages of 76 and 68 and yields of 1,324 and 1,254 pounds per acre respectively. Lowest significant difference for this test was 71 pounds per acre. These data strongly support the regulation that crossing blocks be restricted to the 2x2 type. Some check has also been made on the size of block in relation to crossing percentage. The few data secured suggest that this factor does not have any marked effect on the percentage of crossing.

CULTURAL METHODS

Date of Seeding—The sunflower crop must be seeded early to insure maximum yields of good quality seed. Table 2 gives yield data from different seeding dates at Saskatoon, Saskatchewan, and Altona, Manitoba. These figures show the higher yields which are secured from the earlier plantings or more significantly the low yields which result from late planting. Even though the earlier dates are not the highest at Saskatoon they are to be recommended because they still yield quite well and the danger from fall frosts would be less than on later dates.

Table 2—Pounds per acre sunflower seed from different seeding dates.

Saskatoon, Saskatchewan Mennonite variety		Altona, Manitoba Advance variety	
Seeding date	Yield (3 year average)	Seeding date	Yield (one year)
April 20	717		
May 1	702	May 17	1515
May 10	742	May 24	1176
May 20	869	May 31	1061
June 1	630	June 7	656
June 10	403	June 14	514
L. S. D.	100	L. S. D.	215

As a general statement seeding between May 10th and 20th is recommended for the Red River Valley area and five to ten days earlier for other locations in Manitoba. Planting in late May or June must be avoided. Too often failure of the sunflower crop can be traced to late seeding. Besides low yield late plantings are often damaged by frosts so that seed from them is of low quality. There is little danger of frost damage in the seedling stage on early plantings as the young plants are quite frost resistant. Early seeding also reduces the danger of fall frost damage and allows the crop to dry out well before harvesting so that the seed can be safely stored.

Type of Soil—No definite statements can be made on the type of soil suited to sunflowers. Any soil which will grow corn will grow sunflowers. The crop is more drought resistant than corn and more frost resistant. For these reasons it should be possible to grow sunflowers in Canada over a much larger area than corn is grown at present. Heavy low lying soils which are poorly drained and known to be slow in warming up in the spring should be avoided. Sandy soils have given good yields.

Place of Sunflowers in Rotation—As with most crops summerfallow will likely give the best yields. But as the sunflower is an intertilled cleaning crop the summerfallow could better be used for a grain crop. There is also danger of more disease in the sunflower crop when grown on summerfallow rather than stubble land. Seeding as a third or fourth crop following summerfallow is satisfactory. Seeding after potatoes, beets, or peas, or on alfalfa or sweet clover sod should not be practiced as these crops all carry diseases which attack the sunflower. Sunflowers should not follow sunflowers more than once in four years on the same land.

Farmer experience indicates that oats is the best crop following sunflowers. Good yields have also been secured from wheat, barley and flax after the crop. If using flax it is wise to have arrangements made for spraying for weed control as sometimes there is a heavy growth of volunteers which the flax, being a poor weed fighter, cannot content with. The volunteer sunflowers can easily be destroyed by 2,4-D sprays.

Seed Bed Preparation—To ensure even germination the seed bed should be firm. A firm seed bed will bring the moisture near the surface and permit shallow seeding with rapid and even emergence. Being a row crop, sunflowers do not cover the soil surface as quickly as solid seeded grain crops. For this reason a lumpy condition on the surface of the seed bed or some trash cover is desirable in areas where there is a danger from soil drifting.

Row Spacing—Most farmers in Manitoba seed in rows 36 to 42 inches apart. References on sunflower cultivation in Britain mention spacings between the rows as narrow as 15 inches (3) suggesting that the spacing used by Canadian growers may be uneconomically wide. In 1948 a four replicate test of five different row spacings varying from 18 inches to 42 inches in width was conducted at Altona, Maintoba. The results from this test are presented in Table 3. Though the 24-inch row spacings gave the highest yield statistical analysis of the data shows no significant differences exist. Until further data are secured there is little basis for recommending any change in row width from the present 36 or 42 inches commonly used by growers. It is felt that weed control may be easier with the narrower spacings as they completely shade the soil sooner than wide spacings. Also where the farmer is growing

sugar beets the sunflower could be seeded at the same width, thereby enabling the same cultivator and adjustment to be used in weed control for both crops.

Table 3.—Effect of various row spacings on Advance variety of sunflowers. Plants six inches apart in the rows.

Row spacing	Seed yield lbs. per acre	Plant height inches	Head height inches	Head diam. inches
18 inches	1206	64.2	53.9	4.0
24 inches	1366	64.0	52.1	4.8
30 inches	1300	65.7	52.5	5.0
36 inches	1284	63.4	46.0	4.9
42 inches	1228	64.9	50.8	5.1

No significant difference exists in yield.

Plant spacings—Spacing of plants within the rows varies greatly with the individual farmers, ranging from a solid seeding, spacing the plants five to six inches apart in the row to the extreme of single plants in 42-inch check rows. The effect of various plant spacings has been studied in experimental plots at Saskatoon, Saskatchewan, over a five-year period, (6) by samples taken from farmers' fields in the sunflower area in 1947 (8) and by controlled tests at Altona, Manitoba, in 1948.

At Saskatoon the Mennonite variety was seeded at a heavy rate in rows 36 inches apart. After emergence the plants were thinned within the rows to spacings of 6, 18 and 36 inches. Table 4 shows the average yield and other data secured from these plots over the five-year period. (6)

Table 4—Effect of plant spacing Mennonite variety of sunflowers. Average of five years data. Rows 36 inches apart.

Plant spacing	Seed yield (lbs. per acre)	Head diam (inches)	Height (inches)	Weight per 1000 seeds (grams)	Percent kernel	Percent oil (whole seed)
6 inches	921	4.7	45	61	57	29.1
18 inches	878	6.4	42	74	55	26.4
36 inches	690	6.5	43	80	54	25.4

At Altona in 1948 the Advance variety was employed in a split plot test using 18 and 36-inch rows as the main plots. Sub-plots consisted of plants 6, 12 and 18 inches apart in the rows thinned to the desired spacing after emergence and unthinned seeding rates of 5, 6.3, and 11 pounds of medium size seed per acre basis 36-inch rows. The seeder setting was not changed for the 18-inch rows so that the actual rates would be 10, 12.6, and 22 pounds of seed per acre in these rows. The data from this test are shown in Table 5.

Figure 1. Stand from seeding rate of 2 or 2½ pounds per acre in 36-inch rows. Note large heads hanging near ground or sometimes on ground as at lower left. Such stands yield poorly and are difficult to harvest with a combine.

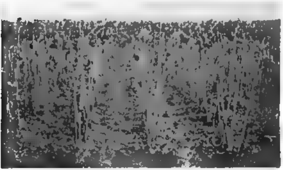


Figure 2. Heavy stand in 36-inch rows from seeding at 4 to 5 pounds per acre. Note small heads carried at good height on fine stems. Such stands give best yields in row spacings of 30 inches or greater and are easiest to harvest.

Table 5—Effect of various plant spacings and seeding rates in 1948 on Advance variety of sunflowers in rows 18 and 36 inches apart. Linear measurements in inches, weights in pounds.

Plant spacing	Plant height			Head diam.			Head height		
or seeding rate/acre	18" rows	36" rows	Mean	18" rows	36" rows	Mean	18" rows	36" rows	Mean
18 inches	55.6	56.4	56.0	5.6	7.0	6.3	40.1	38.0	39.0
12 inches	56.2	57.2	56.7	4.7	6.3	5.5	44.4	41.4	42.9
6 inches	60.8	62.7	61.7	4.2	5.8	5.0	50.1	46.7	48.4
5 lbs.*	62.0	62.2	62.1	4.6	5.5	5.0	53.1	46.7	49.9
6.3 lbs.	67.5	62.7	65.1	4.1	4.5	4.3	52.5	51.2	51.8
11.0 lbs.	65.0	62.7	63.8	3.2	4.0	3.6	56.9	52.5	54.7

Plant spacing	Seed yields			Weight per bushel			Percentage oil, whole seed		
or seeding rate/acre	18" rows	36" rows	Mean	18" rows	36" rows	Mean	18" rows	36" rows	Mean
18 inches	1322	1097	1210	29.2	28.4	28.8	35.18	34.65	34.91
12 inches	1288	1056	1172	29.6	28.6	29.1	35.51	33.65	34.58
6 inches	1065	1185	1125	30.5	28.4	29.5	34.96	35.29	35.12
5 lbs.	1225	1158	1192	30.1	29.4	29.8	35.76	35.30	35.53
6.3 lbs.	1032	1096	1064	31.6	30.4	31.0	35.91	35.59	35.75
11.0 lbs.	758	1052	905	31.9	31.2	31.5	36.01	35.63	35.82
Lowest significant difference	202**	none**	137			0.9			.65

**Analysis of row spacings separately as simple randomized tests. *See text.

The data from Table 4 and that from farmers' fields collected in 1947 (8) show that narrow plant spacings of six inches as compared with wider spacings will give the higher yields in rows 36 inches apart. While the data of Table 5 show the 18-inch plant spacings to give the highest yield it is seen that this is due mainly to the high yields of this spacing in the 18-inch rows. Considering the 36-inch rows alone it is seen that the plant spacing of 6 inches and the comparable spacing in unthinned seeding rate of five pounds per acre which was recommended in 1948 have given the highest yields, thus supporting or at least not being in disagreement with the conclusions which were drawn from previous work (6, 8). The yields of the 18-inch rows are not consistent. The 6-inch plant spacing differs significantly from the higher yielding and wider 12 and 18-inch plant spacings. The difference between the six-inch spacing and the five-pound rate which yielded higher also approaches significance. The heavy rates of 6.3 pounds per acre and 11.0 pounds per acre both differ significantly from the higher yielding 12 and 18-inch plant spacings. This would suggest that for highest yields in 18-inch rows the plant spacing be wider than six inches.

Considering other factors the results are fairly consistent for both row spacings, as well as with previous work. As plant spacing decreases plant height and head height increases, while head diameter decreases. The closer spacings also yield seed of heavier weight per bushel and higher oil content. With the exception of increased plant height all these features of the closer spacings are desirable. Smaller heads dry faster in the fall permitting earlier harvesting. Greater head height permits easier handling of the crop and less loss at the cutter bar. Higher weight per bushel allows easier cleaning of the seed and storage of greater weight in a given volume. The advantage of higher oil content to the crusher is obvious.

Plants Per Hill in Check Rows—Studies of samples from farmers' check row fields in 1947 (8) showed four to five plants per hill were more desirable than smaller numbers. They gave the same benefits of higher yield, smaller head size, greater head height, higher weight per bushel, and higher oil content that have been obtained from close plant spacings in 36-inch rows.

In 1948 a split plot test using three hill arrangements of 36x36 inches, 36x18 inches, and 18x18 inches as the main plots and 1, 2, 3, 5, 7 and 9 plants per hill as the subplots was conducted at Altona, Manitoba. Yield data and plant characters are presented in Table 6. At time of writing weight per bushel and percentage oil determinations were not completed in this test.

It is seen from these results that there is an increase in yield in the hills spaced 36 inches both ways as the number of plants per hill increases. Differences in the 36x18 arrangement are not notable while in the 18x18 arrangement the single plants in each hill have given by far the largest yield. Behaviour of the plants in other respects as the number of plants per hill increases is similar to that observed on increasing the rate of seeding in solid seeded rows as discussed under "Plant Spacing".

Table 6. Effect of three hill arrangements and six different numbers of plants per hill on Advance variety of sunflowers in 1948. Linear measurement in inches, weights in pounds.

Plants per	Plant height				Head diameter				Head height				Seed yield			
hill	36x36	36x18	18x18	Mean	36x36	36x18	18x18	Mean	36x36	36x18	18x18	Mean	36x36	36x18	18x18	Mean
1	59.5	60.2	61.8	60.5	9.6	7.7	7.3	8.2	35.7	41.0	45.0	40.6	937	1297	1947	1394
2	63.8	66.2	67.8	62.9	7.7	6.5	5.5	6.6	42.0	50.0	54.8	48.9	1163	1485	1734	1461
3	65.8	66.4	66.7	66.3	5.8	5.3	4.4	5.2	50.8	53.3	55.3	53.1	1167	1514	1474	1385
5	64.4	68.3	68.7	67.1	5.8	4.8	3.7	4.5	49.2	56.4	59.2	54.9	1279	1518	1074	1290
7	66.2	67.8	68.5	67.5	5.7	4.4	3.4	4.5	49.2	57.1	60.4	55.6	1372	1380	1064	1272
9	67.4	67.9	69.4	68.2	5.1	4.2	3.1	4.1	54.2	58.2	61.6	58.0	1423	1148	822	1181
													1223	1390	1352	

Lowest significant difference yield plants per hill. 107 lbs.

Lowest significant difference yield hill arrangements. 109 lbs

It is interesting to note that both in this test and the one reported under "Plant Spacing" the arrangement of single plants spaced 18 inches apart both ways has given highest yields. Should repeat tests give similar results in future years this arrangement would recommend itself. Chief objection from the farmers' standpoint would be that the heads are large and consequently would tend to hang down making them difficult to gather with the combine and slow in drying out during the fall. When a variety with stronger stem than the present Advance is developed this objection would probably be overcome. From a practical standpoint at present it could be remedied by planting two plants per hill which might not reduce yield drastically and would give considerable increase in head height as can be seen from the data. Since these tests are based on perfect stands, two plants per hill should be recommended because in practice perfect stands are rarely attained. Should skips occur in stands of one plant per hill they would cause plants with huge undesirable heads in the adjoining hills (see figure 1). Fewer blank hills would be expected in a stand of two plants per hill, therefore they should be used in preference to one plant per hill for this 18x18-inch arrangement.

Recommended Seeding Rates—Table 7 gives the recommended seeding rates in pounds per acre for Advance first generation sized seed for row widths from 18 to 42 inches. These rates are based on a seed being dropped every five to six inches of row length for the 30, 36 and 42-inch rows and every 9 to 10 inches for the 18 and 24-inch rows. The wider spacing is suggested for the narrower rows because the data of Table 5, discussed under "Plant Spacing" show that better yields were secured from such spacings in the 18-inch rows. The rates also assume seed of 90 per cent germination or better. Sunflower seed generally has high germination but if the grower is using a sample known to be of low germination then increased rates should be used to allow for this deficiency.

Table 7. Recommended seeding rates for Advance first generation basis seed germinating 90 per cent or over, weights in pounds.

Row spacing	18"	24"	30"	36"	42"
Small size	4⅜	3¾	4⅛	3¾	3¼
Medium size	5⅜	4⅓	5½	4½	4
Large size	6½	5½	6¼	5⅛	4⅝

It is the practice of Co-op. Vegetable Oils, who clean and market most of the first generation Advance seed, to divide it into three sizes. According to yield tests conducted in 1948 there is no difference in the yielding ability of the different sizes. They are merely to give samples which will flow more uniformly in the planting machinery than unsized seeds. The small size is recommended for grain drills and either the medium or large for corn or beet planters. For check rows of 36 inches or 42 inches both ways, five plants or more per hill are recommended. Correct seeding rates for the 42-inch row on this basis would be 2½, 3 and 3¼ pounds of small, medium or large seed per acre respectively. Allow one-quarter pound more for the 36-inch check row.

Seed Treatment—No conclusive data on the value of seed treatment for sunflowers has been secured. Generally speaking, seed treatment is good cultural practice for any crop and sunflowers should be no exception to this

rule Rates of treatment up to 1½ ounces per bushel of New Improved Ceresan or Arasan seem satisfactory No undesirable effect on stand has been noticed using these rates

Fertilizers In 1948 in co-operation with Consolidated Mining and Smelting Company of Canada, Limited, a strip test was conducted near Rosenfeld using two different fertilizers in the run with the seed. The results of this test are shown in Table 8. No significant differences in yield were secured. However growers' beliefs do not agree with these findings. Also the results of Soine (10) in Red River Valley soils in Minnesota show an excellent response from fertilizers, especially those containing phosphorous or potassium and phosphorous.

Table 8—Results of fertilizer strip test at Rosenfeld. Manitoba, 1948. Advance variety

Fertilizer	Rate per acre	Pounds per acre dry seed	Difference significant	Moisture content of seed at harvest	Difference significant
11-48-0	36 lbs.	739		12.6	
			No		Yes
	Check	719		15.9	
16-20-0	24 lbs.	726		13.2	
			No		No
	Check	722		13.8	
16-20-0	48 lbs.	745		12.8	
			No		Yes
	Check	736		16.0	

Regardless of yield consideration fertilizers are of value in speeding up the maturity of the crop as shown by the lower moisture content of the fertilized plots at harvest time. This factor in itself is sufficient to warrant recommending fertilizer to secure earlier harvest and drier grade seed. The general recommendation at present is a minimum of 30 pounds of 11-48-0 ammonium phosphate per acre

Depth of Seeding—As the sunflower seed has a large hull it requires a good supply of moisture for germination. It is important therefore that the seed be planted into moist soil. The crop has a large seed so that it can be planted up to four inches deep without danger of poor emergence. As a general statement plant deep enough to be certain of having the seed into moisture. Shallow seeding, providing the seed is in moist soil will give earlier emergence than deep seeding.

Cultivation—The sunflower has been called a cleaning crop, but it or no other crop can be such if not properly cultivated. If possible one crop of weeds should be destroyed before planting. Seeding should follow immediately so that the crop will have an even start with the weeds remaining in the soil. Many growers give the field a light cross-harrowing just before the crop emerges. This can be followed by one or two light harrowings when the plants are in the four to six leaf stage. Only light wood or diamond harrows should be used. This work should be done on warm clear days to secure best weed kill and least breaking of the sunflower plants. A firm seed bed also reduces damage to the stand in this operation.

Later, cultivation between the rows is necessary. The number of cultivations will vary with the weediness of the land. An early shallow cultivation is desirable operating as close to the rows as possible. This should be followed by one or two later cultivations, throwing the soil towards the base of the plants to cover small weeds. The last cultivation should be as late as it is possible to operate row crop machinery in the stand without breaking off plants. Deep cultivation should not go near the plants as there is danger of cutting off branch roots, reducing the vigor of the plant and its ability to stand erect at maturity.

Sunflowers and 2,4-D. Great care must be taken when using 2,4-D weed killer near sunflowers. The sunflower plant is one of the most susceptible known to damage by this chemical. Drift from small grain fields sprayed or dusted with 2,4-D will do serious damage to adjoining sunflower fields. This damage can often be noticed 100 feet and more from the point of application of spray. In 1948 one field, 20 rods wide, was damaged so severely that it was later plowed down by the owner. Therefore it is recommended that this chemical be kept at least 100 feet from any sunflower field and that it be used only during calm weather or better when the drift is away from the sunflower field. It is also felt that use of the salt formulation and probably the amine will entail less risk of damage than the ester.

Because the crop is so susceptible to 2,4-D injury volunteers in grain crops following a sunflower crop can easily be destroyed. Two ounces of acid per acre in any formulation will give effective control.

Harvesting. The sunflower crop is usually ready for harvesting about the middle of October if it has been seeded in early May. For safe storage the seed should not be binned with a moisture content over 12 per cent. It is possible to store seed in farm bins with a moisture content up to 14 or 15 per cent during cold weather but the practice is not recommended. Authorities on this subject state that the safe moisture level for storage under all weather conditions is 9.5 per cent (4, 11). While some shattering and bird damage may occur the amount is small so that the crop can be left standing safely in the field until the moisture content is low enough for safe storage.

If in doubt the grower should secure a moisture test of his seed sample rather than run the risk of losing or damaging his entire crop. Any grain elevator equipped with the Brown Duval moisture testing apparatus can make a test on sunflower seed. Fifty grams of seed are used with 150 c.c. of S.A.E. No. 10 oil. Temperature is raised to 175° Centigrade, the heat removed and the moisture reading taken when the temperature has dropped to 160°. Because only 50 grams of seed are used instead of 100 as with most grains, the moisture reading must be doubled to obtain the correct figure.

Of harvesting machinery the most practical implement to use is a combine. Cutting with corn or grain binders and then using a threshing machine has been tried but is not recommended. Hand cutting requires a great deal of labor and is slow unless the heads are large. In this regard it has been shown under "Plant Spacings" that the thinner stands which give large heads most suitable for hand cutting do not give high yields of seed. For special plots such as production of high priced Advance first generation seed, hand cutting may pay for the added labor cost, through seed saved. It also has the added advantage

Figure 3—Self-propelled auger type machine. Reel forward and raised with four extended arms filled in completely and heavy belting at the edge. The pans on this machine were replaced by those illustrated in figure 7.

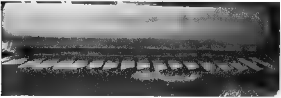


Figure 4. Front view of combine with small reel working behind convex sheet metal guard. Pans about seven inches wide.

Figure 5 -Side view of same combine as illustrated in figure 4 Note different position of small reel and convex guard as compared with figure 6, indicating various adjustments with different operations.

Figure 6 -Side view of similar changeover of combine to that illustrated in figure 4 and 5. Pans 15 inches wide mounted 18 inches centre to centre.

of eliminating danger of mixtures, an important factor in securing good grades on this seed.

Combines equipped with a rubbing bar type of cylinder are the most desirable as they cause less damage to the seed than the spike tooth type and break up the heads less, a factor which makes separation on the sieves easier. As the heads and stalks have a tendency to catch, machines with a simple feeding mechanism and ones which pass the material directly from the cylinder to the straw decks are most satisfactory. The self propelled type of combine and small "straight through" machines have both done good work. A machine on which the cylinder speed can be reduced without lowering the speed of the decks is essential.

For suitable threshing the cylinder speed should be reduced to about one-half of that used for cereal grains and the concaves opened widely. The seed is easily threshed. The head should be broken up as little as possible so that the sieves in the shoe will not be heavily loaded. Too much trash on the sieves will prevent free flow of the wind blast through them and interfere with proper cleaning. The centre of many heads often contains only blind or empty seed. It is often indistinguishable from normal seed but it is held tighter in the head. Thus if one finds heads going over with seed in them they should be checked to be sure it is not this blind seed before increasing the cylinder speed or closing up the concaves. The cylinder speed and concave setting should be such that all good seed is being removed from the heads and no more. This will give least breakage of the head and easiest cleaning.

If the conventional type reel is retained it requires special attention in harvesting sunflowers. Heads will frequently hook over slats of normal width and be thrown or dropped clear of the machine. Such loss can be reduced by making a solid reel. This is most commonly done by filling in the reel with thin boards. Heavy gauge wire of fine mesh such as one-half inch hardware cloth can be used and will give less wind resistance than the solid boards. The reel should run high and at the same time sweep close to the cutter bar. To achieve this the reel arm is often extended 8 to 12 inches. The extension is usually attached at an angle of about 30 degrees with the reel arm in the direction of rotation. This permits the reel to strike the stem of the plants first, directing them back to the cutter bar. The straight slats often come down on top of the heads and in some cases break them off or push the stems away from the knife rather than towards it. Other operators attach the extension with hinges which permit it to drop between the heads as the reel arm comes down. From observation it appears such a method causes more shattering than when the extension is held firm. Still other operators use a piece of wide heavy belting for this extension with good results. Besides these changes the reel is often reduced from six to four arms. This change is illustrated in figure 3.

During the 1948 season attachments were developed which eliminated the conventional reel. In its place a reel with three short arms was substituted operating behind a large convex sheet metal guard. Details of this construction are illustrated in figures 4, 5, 6, 7 and 8. Considerable variation in the positioning of this equipment in relation to the sickle and in the size of parts was noted. On one machine illustrated in figure 6, the reel arms were 12 inches long with the reel shaft mounted 15 inches above and six inches in front of

Figure 7 -Common type of pan used with small reel and convex metal guard, 15 inches wide, 18 inches centre to centre mounted over regular guards

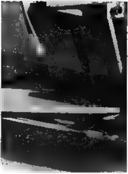


Figure 8— Side view of pan showing supporting angle iron brace and regular guards still on machine.

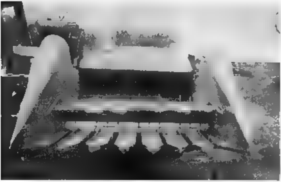
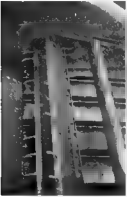


Figure 9- John Deere manufactured harvesting attachment fitted to their Model 12A combine. Similar attachments are available for the self-propelled No. 55 machine.

the sickle. The convex sheet metal guard was built of 28 gauge sheet metal on a frame of one-quarter inch vertical strap iron and 1x4 horizontal wooden strips running the width of the machine. The outside measurement over the curve was 36 inches with the outer edges 30 inches apart. This guard was mounted in front of the reel with the lower edge 18 inches in front and 8 inches above the sickle.

Along with these alterations pointed metal pans one inch deep were attached to the cutter bar above the conventional guards by using guard bolts longer than normal. These pans were most commonly four and one-half feet long and 15 inches in width, mounted 18 inches centre to centre thus covering six guards and leaving a three-inch space between. Points were made by tapering from a line 15 inches from the front. While 15 inches was the most common width, these pans varied from six inches to a width only three inches narrower than the spacing between the rows being harvested. No. 16 gauge iron was most commonly used in their construction though the very wide ones were sometimes made of an angle iron frame and filled in with light gauge sheet metal. A single light angle iron support was attached 20 inches from the front on the underside of those up to 15 inches in width and ran back to a heavy angle iron mounted on the auger housing or under the table (see figure 8). On wider pans two of these supports were necessary.

In operation this equipment acts as a stripper. The stems are pushed by the sheet metal guard and slide between the pans until the head passes under it when they are cut off and thrown into the auger or onto the platform by the reel. The pans catch most of the seed which is shattered besides guiding the stems.



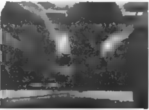


Figure 11—Worm's eye view of John Deere attachment illustrated in figure 9 showing driven rasp bar to assist in pulling stalks between the pans.

Figure 10—Bird's eye view of idling roller and beater of John Deere attachment shown in figure 9.

These developments have solved the harvesting problem in sunflowers. In comparison with the conventional reel there is much less loss from shattering of seed and heads being thrown clear of the machine. On self-propelled combines the vision is also much improved. Further there is no danger of damage to reel sprockets and chains such as occurrs in high winds when the conventional reel is filled in solid.

The guard and pans can be made up and installed in most local machine shops. Those made in the sunflower growing area in the fall of 1948 cost about one hundred dollars for material and labor for a 12-foot machine. This equipment is installed on auger type machines most commonly, but can be fitted to canvas platform machines also.

The John Deere Machine Company has an attachment similar in principle to fit both their No. 12A small pull type combine and No. 55 self propelled machine. Instead of the large sheet metal guard they use an idling roller. A rotating rasp shaft mounted below the sickle assists in pulling the stalks down. Illustrations of this attachment are shown in figures 9, 10 and 11. For prices and availability the reader is advised to contact his local John Deere dealer.

Diseases—Sunflowers, as with all other crops are subject to attack by various diseases. Fortunately in Manitoba there has been no serious loss from disease on the crop to date. Rust and Sclerotinia are the two most important diseases attacking the sunflower crop.

The rust attacking sunflowers passes through all its stages on the sunflower plant. It does not have an alternate host such as the barberry, which is necessary to complete the life cycle of wheat stem rust. Spores from one year can lay dormant in the soil over winter and be ready to cause infection on the sunflower plant the following season. Effect of the disease can be reduced by seeding early, avoiding sunflowers on the same land two years in succession and plowing under the stubble to bury the spores and minimize chances of infection from them. Differences in resistance to rust have been noticed between strains of sunflowers in breeding nurseries. Though there has been no need to the present for resistant varieties, the presence of the disease should make rust resistance a primary objective in any breeding project. The observations made would indicate that resistant strains can be secured.

Sclerotinia disease in sunflowers causes a rot usually at the base of the stems. In early stages the affected areas will show a white mouldy growth which later on dry up and often leave the stem in a shredded condition. Plants attacked will wilt in a few days and often break over. The white colored rotted areas will contain black irregular shaped bodies from one-quarter to one inch long called sclerotia. These bodies drop to the ground. They will remain alive in the soil for a period of one year or more, and when conditions are right for them, germinate to produce spores for a new infection. They can also produce infection by direct penetration through the roots of the plants. This disease attacks many fleshy plants including potatoes, beets, alfalfa, peas and sweet clover and also a variety of fleshy weeds such as sow thistle and pigweed (13)

To reduce danger from the disease it is not wise to sow sunflowers following these crops or to sow them on the same land more than once in four years. Sowing after a cereal grain crop is recommended instead.

Another disease which has been observed in 1947 and 1948 is a bacterial stem rot. Plants attacked will have the stem full of soft jelly-like rot with circular black areas on the outside which will coalesce to give a weak spot, causing the stem to break over. In mature stages the disease may be mistaken for the rot caused by **Sclerotinia**. The main differences are absence of the sclerotia and the characteristic shredding and a brown stem rather than white colored stem common in the Sclerotinia rot.

Other diseases caused by organisms also attack sunflowers. **Botrytis** or grey mould has been found serious in Great Britain (3). The organism lives mainly on dead or dying tissues causing rotting particularly of the head of mature plants standing in the field. Since it is a disease which thrives in moist weather common to Britain there is little danger from it in the drier climate of Manitoba and the central plains of North America where the sunflower is a potential crop. **Septoria**, causing a leaf spot and downy mildew (**Plasmopora, sp.**) have also been noted in Manitoba but so far have caused no significant damage.

Insects and Pests—The sunflower is subject to attack by wireworm, cutworm, beet webworm and grasshoppers, all of which attack most other farm crops. Many publications are available outlining standard procedures for the control of these insects, so no space will be devoted to them here. If information concerning their control is desired the nearest agricultural representative should be contacted. A number of insects attack sunflowers in particular. Included are the sunflower moth **Homoeosoma electellum**, a species of **Phalonia** for which no common name has been adopted, and the sunflower leaf beetle, **Zygogramma exclamationis**. Of these the first two mentioned appear most important.

The sunflower moth is a delicate gray moth with a wing spread of about one-half inch. Eggs are laid on the head at or shortly before flowering time. The larvae are about one-half inch long, brownish in color with lighter stripes on the back. They tunnel through the head devouring seeds, leaving a large amount of silken frass and doing heavy damage if present in any numbers. This insect has been held in check by natural parasites. Also the variety Advance is credited with resistance to it. The resistance is attributed to a dark layer of pigment which can be observed under the outer seed coat by scraping it off. This layer is referred to as an "armour layer" or "carbon layer". Histological observations show it to be a solid dark mass between the corky layer and the rigid portion of the seed coat (7). It is suspected to be resinous in nature. Preliminary studies indicate that the layer is simply inherited and can be easily introduced into new varieties. Further work with the object of increasing the thickness of this layer and having it produced at an earlier stage in the seed development are desirable.

The **Phalonia** species was first noticed in 1944 in the Manitoba area. In 1947 and 1948 it was present in large numbers in some fields. The larvae, which are the destructive stage, are about three-eighths of an inch long and vary in color from white when young through to red and finally green at

maturity. They appear to enter individual seeds near the point of attachment of the flower, eat the kernel and then leave. Individual larvae will not do as much damage as the sunflower moth because they do not burrow tunnels through the heads. However, large populations in single heads can be destructive. The larvae pupate in the fall at the base of the plant and in plant residue. It is felt some measure of control can be secured by deep fall plowing of sunflower stubble which will bury the pupae too deep for the adults to emerge the following spring.

The sunflower leaf beetle, as the name implies, eats the leaves of the plant. It works chiefly in the leaves near the flower. The adult beetle is similar in appearance to the potato beetle but slightly smaller. The larvae are also smaller than those of the potato beetle and green in color rather than brick red. This insect has not caused any economic damage to the crop in Manitoba. Even the few plants attacked have not been stripped of all their leaf surface. If populations should reach serious proportions spraying programs would appear to be the only control method.

Other pests would include a variety of birds and rodents. Blackbirds, goldfinches and sparrows will eat considerable seed from maturing fields that are isolated or happen to be near wooded areas or streams and waterholes. However, over extensive acreages their damage is not serious. Rodents including mice and gophers will sometimes follow a seed row, digging up and eating seed. They are often a serious hazard to establishing a good stand in experimental plots but are of little consequence on commercial acreages. Packing following seeding will help to reduce their damage.

Are Sunflowers Hard On the Land? As a general statement farmers' experience indicate that sunflowers will take more from the land than a crop of corn and less than a crop of grain. Some growers, however, have reported land following sunflowers to be equal to summerfallow or land following corn. The writer feels that the belief that sunflowers are hard on the land is a carryover from the period when the Russian Giant variety of sunflowers was grown in the west as a silage crop. These crops were allowed to grow 8 to 10 feet high and would naturally take more moisture and nutrients from the soil than any of the dwarf types grown for seed. Experimental work in Idaho (2) on the silage type crop reports that yield of spring wheat was almost normal following sunflowers. Further data comparing the nutrients used by 10-ton crops of silage corn and sunflowers show that the sunflowers used more potassium and calcium but less of the important elements nitrogen and phosphorous. (6) Since there are good quantities of potassium and calcium in Western Canadian soils the sunflower crop should not be detrimental on this score. Furthermore, if the high sunflower stubble is allowed to stand over winter, it will hold more snow than grain crop stubble. While the value of such snow is debatable it certainly can do the succeeding crop no harm, and may do it some good.

THE INDUSTRIAL PLANT AND PROCESSING

EARLY DEVELOPMENTS

(Revised January, 1950)

Interest in the construction of a plant for processing the sunflower seed crop was first stimulated in 1943. It became apparent that southern Manitoba contained the potential for an extensive acreage of sunflowers in a relatively compact area ensuring an adequate supply of raw materials for such a plant. Another most important consideration was the fact that the only crushing facilities for the 1943 crop were in Eastern Canada. Freight rates quoted from Altona, the centre of the sunflower area, to Toronto were $1.14 per 100 pounds. Considering that the sunflower seed is about 50 per cent hull or inert material this rate meant an actual charge of $2.28 per hundred pounds of oil bearing seed or meats delivered from the area to the crusher. Further keeping in mind that the meats produce 50 per cent feed cake on processing the charge for freight alone in the price of meal from the cake would be over $45.00 per ton at Toronto. A further freight levy would be added if the Western farmer were to have the meal shipped back for feeding his own livestock.

In addition to these factors many growers felt that their interest in the crop need not cease with its harvest. If the production of the crop was to benefit the country as a whole the primary producer should share the reward. There appeared to be no need for the products to be funneled out of the area where they were produced. The oil would be consumed in Western Canada. Probably all the meal could be utilized in the west. Livestock nutrition in Western Canada was recognized as being at a low level. In the cake was a high quality feed product which if retained in the area might correct this situation.

With these considerations in mind a group of farmers met in September 1943, and laid plans for a producer co-operative to construct a suitable plant for processing the sunflower seed crop. As with all construction projects at this period great difficulty was encountered in procuring the necessary materials and also in obtaining certain essential machinery. Financing the construction was also difficult, several increases in the estimated cost of construction being necessary. However with continued perseverance by the board of directors and support from farmer growers, as well as co-operation of the Oils and Fats Administration in securing priorities, the plant was completed and extraction of oil commenced in March, 1946. The provincial government of Manitoba was also helpful in providing a guarantee for the first bond issue of $60,000, which has now been retired. Total membership in the organization, Co-op. Vegetable Oils Limited, is now over 2,300 being almost all Manitoba growers as well as a number in the United States.

Plant Description.—Constructed at a cost of over $700,000 the plant now consists of six main buildings: the boiler house, plant building, frame elevator, fire-proof elevator, Press-to-log building and office and refinery building. Miscellaneous buildings include a tool house, laboratory, fire station, restaurant, seed cleaning plant, seven large oil storage tanks, and three large seed storage annexes. Private spur tracks pass all the main buildings.

The boiler room is of reinforced concrete, equipped with two 80 h.p. boilers,

fed by automatic stokers burning lignite coal. Storage for over 100 tons of coal is provided. All pumps and water levels are controlled by automatic electric switches. Water is carefully analyzed daily and correct chemicals added to prevent scaling of the boiler.

The plant building, approximately 52 ft. by 90 ft. long, consists of three main rooms and temporary offices. The first room contains the oil extraction equipment. This consists of three Anderson Super-Duo expellers, screening tank, elevating legs, conveyors, oil pumps, etc. The second room, called the mill room, contains two dehullers, a large bin for meal cake storage, a hammer mill for grinding the meal, and bag conveyors to the spur track. The equipment in these two rooms will process approximately 170,000 pounds of sunflower seed per 24-hour day of continuous operation.

The third room contains two 30-inch plate and frame filter presses which filter the crude oil. Here the oil is also weighed into a scale tank and then pumped into the large storage tanks outside.

All machinery in this building is the most efficient obtainable. Individual electric motors totalling more than 600 h.p. are used for power.

The frame elevator building is 70 ft. high with bins 32x100 ft. and 30 ft. high, having a storage capacity of over 1,000,000 pounds of seed. This was the first elevator constructed, handling all the seed delivered to the plant. It is now used mainly as a storage and transfer building.

The new elevator, completed in 1949, is of all concrete construction. It is about 114 ft. high, approximately 36 ft. wide and 52 ft. long. It is equipped with two large efficient seed cleaners and two Morris grain driers.

The new elevator will permit deliveries of 500,000 to 600,000 pounds of seed per day, which it can clean, dry and transfer to the plant or to storage buildings. The elevators, with the three annexes, provide storage capacity on the plant grounds for over 8,000,000 pounds of seed.

The Pres-to-log building is connected by blower pipes with the dehullers in the plant building. When the hulls enter this building, they are fed by conveyors to two Pres-to-log machines which process the hulls into fuel logs. These machines produce over 5,000 logs per day, each weighing from seven to seven and one-half pounds.

The Extraction Process—Seed delivered to the elevator is first cleaned and dried to a uniform moisture content of 7 per cent. It is then transferred to the mill room and elevated into the dehullers. These machines consist of two large plates similar to common grain grinder plates. It breaks the hull loose from the meat part of the seed. After passing the plates the material goes over a shaker screen. Above this screen a large suction fan is mounted which lifts the hulls off and blows them to the storage bin of the hull house. Seed meats with approximately five per cent of hulls drop through the screen and are delivered to the meat storage bin in the expeller room. Unbroken seeds are passed back through the dehuller.

The meats are fed into cookers attached to the expellers where they are treated at 240° Fahrenheit for one hour. This is followed by twenty minutes in a conditioner barrel at 260°. These heat treatments permit the maximum percentage of oil to be removed from the meats. Following treatment the seed

passes into the expellers. These machines consist of two augers encased in barrels made of heavy steel bars. The spacing between the bars is five one-thousand of an inch. In forcing the meats through these barrels sufficient pressure is generated to drive the oil between the bars with a small quantity of meats which are termed "foots." The balance of the meats leave the expeller as seed cake.

From the expeller the oil flows to the screening tank constructed to remove a large portion of the "foots." It is then pumped to a small storage tank containing an agitator which keeps the remaining "foots" in suspension. From this tank the oil is forced under air pressure through the filter presses. Numerous sheets of heavy canvas retain the "foots" and the oil flows from the filter presses in its final clear form to the scale tank where the weights are recorded.

From the scale it is pumped to outside storage tanks ready for reweighing and loading into tank cars or tank trucks. The "foots" contain a large amount of oil. Equipment is provided to feed them slowly back through the expellers to reclaim this oil and give greater efficiency in the extraction process.

Seed cake from the expeller is delivered by auger and elevator to the mill room. Here it is tempered to uniform moisture level, ground by hammer mill, weighed and bagged for shipment.

THE PRODUCTS

Sunflower Seed Oil. The oil is the most important single product from the plant. In six weeks' operation on the 1945 crop over one-half million pounds were produced. From the 1946 and 1947 crops a total of almost 6,000,000 pounds were secured. From the 1948 crop nearly 9,000,000 pounds were obtained, and it is expected a similar amount will be secured from the 1949 crop.

Except for small amounts sold locally, all this oil has been sold to other refiners and to the packing house firms. No export was permitted until 1949. The firms who have refined this oil have sold it mostly as a salad and cooking oil, while some of it has been blended with other fats and oils in the manufacture of shortening and oleomargarine.

The oil is very high in quality. Firms purchasing it report a low refining loss. It is classified as a semi-drying oil, being intermediate in this character between linseed oil and olive oil. It possesses only slight odor and is pale yellow in color. Besides its use in the manufacture of shortening no better oil is available for salad oil, deep frying and oleomargarine production. It has also been used for a base oil for liniments and has been recommended by qualified druggists as a substitute for olive oil in their trade. The crude oil as it comes from the plant is of such good quality that several bakeries have purchased and used it in their products without any further refining.

Sunflower Seed Meal—Total production of sunflower meal for the first three crops was slightly over 6.5 million pounds. Production from the 1948 crop was about nine and one-half million pounds. This meal is a high quality protein concentrate. Analysis shows it contains 40 to 50 per cent protein and five per cent fat. The proteins are of higher digestibility than competitive feeds such as soybean meal (12). At least one group of workers (1) have described it as the most complete source of vegetable protein for chick growth that they have studied. Besides its value from the protein standpoint the

vitamin content of the sunflower meal is much higher than that of other seed meals, particularly in carotene, thiamin and niacin. (15).

The suggestion has been made that this meal is too valuable to be used as a livestock feed, that instead it should be used as human food. In this connection millers in Cuba at one time were required to incorporate 20 per cent of sunflower meal in their wheat flour. Housewives in the vicinity of Altona have used small quantities in their baking with success. The University of Illinois reports a variety of cakes made by replacing 10 per cent white flour with sunflower meal to be quite attractive. (16).

Pres-to-logs—Following extensive investigation the hulls are now being prepared into the specialty fuel known as Pres-to-logs. This fuel, in the form of a log, four inches in diameter and 12½ inches long, weighing about seven and one-half pounds is made by compression. Final stages of the process exert pressures up to 165,000 pounds per square inch. With these huge pressures no binder is necessary so that the resulting fuel, which is two to three times as dense as wood, is also clean to handle.

Compared with lignite coal these Pres-to-logs have a B.T.U. value of approximately 8,100 per pound or about 1,000 higher and about one-quarter as much ash. Early use of them on a commercial basis shows they are a good fireplace fuel and ideal for cooking ranges where a fast heat together with longer lasting ability than wood is required. In a fuel-scarce area such as Manitoba they have found a ready market.

Besides being made into Pres-to-logs large quantities of hulls in ground form have been used as feed. They contain about five per cent protein and two per cent fat, but a high percentage of crude fibre. Added to such feeds as ground barley or oats, farmers have found them useful in reducing these strong feeds to levels more suitable for economic consumption. In unground form the hulls have been used as a fertilizer to assist in aeration and addition of humus to low lying land. They are also an excellent chick litter having the desired insulating property and moisture absorbing ability.

THE PROSPECTS FOR THE FUTURE

It can be admitted that the sunflower seed and oil industry for Manitoba is one which has come into existence on the crest of a war-born scarcity of vegetable oils. However, war conditions were a decided detriment rather than an asset as far as actual erection of the extraction plant was concerned. Shortages of material and continually rising costs even threatened to make the development impossible at one time. Nevertheless the question remains, how permanent is the industry?

There is little doubt that the market for the products is available. Canada imports 95 per cent of her total consumption of edible oils. It has been stated that there is a potential market for 20 million pounds of sunflower seed oil in Western Canada alone. This is approximately four times the present production. It is also likely that a similar increase in meal production would be readily absorbed.

What is the cash position of the crop? The growers received five cents

per pound for their 1943-1946 crops. The price for the 1947 crop was six cents per pound, as is the price being paid for the 1948 crop. It is probable that a long time average yield for the crop will be 600 to 800 pounds. With the Advance variety the figure will more likely range near the 800-pound mark. Yields of 1,000 pounds per acre are common. These average yields give the farmer a return of $36.00 to $48.00 per acre for his crop on the basis of six cents per pound. Considering prices of competing oils on the Western Canadian market during the past depression it is felt that the lowest price the grower may ever expect for his crop is three cents per pound or a gross return of $18.00 to $24.00 per acre. It should also be remembered that if the producer is a member of the producer co-operative he will secure the complete earnings from the processing of his seed as a patronage dividend. These dividends have been substantial on crops processed thus far.

Table 9 from data contained in official reports gives the return per acre from other crops grown in Manitoba over the ten years—1937 to 1946. From these figures it can be seen that a substantial drop in the price of sunflowers could occur and the crop still be on a competitive basis with others. It should be remembered also that if any drastic reduction in the price of sunflowers occurs it is likely that the price of other grains will be reduced too.

Table 9—Yield and cash return per acre from Manitoba crops basis 10-year average, 1937 to 1946, compared with expected data for sunflowers.

Crop	Yield per acre bus.	Average price at point of shipment	Gross cash return
Wheat	20.6	$ .89	$18.33
Oats	33.1	.385	12.64
Barley	25.8	49	13.77
Rye	15.4	.811	12.59
Flax	8.4	1.84	15.48
Potatoes	66.9*	1.05	70.24
Sunflowers	600**	.03-.06***	18.00-36.00
Sunflowers	800**	.03-.06	24.00-48.00

*Centals (100 pounds)

**Pounds per acre expected.

***Lowest ever expected and present price respectively

Aside from the cash considerations which show the sunflower in a favorable position compared with other crops many other factors are involved. The crop is another development in the continuous effort to remove the farmer from the one crop or wheat economy. Furthermore, it is not a crop which has to be fed to livestock before a return can be realized. It is a cash crop instead. The crop is also a row crop. As such it does not demand summerfallow or the best land for planting, but instead is a beneficial cleaning crop and summerfallow substitute in itself.

The crop has been the means of developing a local industry in the oil extraction plant. This is a step in the right direction toward greater industrial development in Western Canada. It is estimated that 150 to 200 persons gain

their livelihood directly from this plant. By retaining the meal cake in the area it has possibilities of placing the livestock industry of the area on a more stable basis. The assistance in a regional fuel shortage through production of Pres-to-logs from the hull is also notable.

What of the prospects for extended acreage? What are the hazards which may reduce or eliminate the crop? Answers to these questions can only be speculative. Both the crop and the products from it are new in Canada and the North American continent. The oil and meal have only recently received the attention of chemists and nutritionists. It is always possible their work will develop new and extended uses for the products. Farmers in an ever expanding area are recognizing possibilities of the crop.

At the turn of the century wheat was a new crop for much of Western Canada. The activity of professional workers in their development of new varieties and improved cultural practices has put the wheat crop on a sound basis over a large area. They have successfully met the hazards as they have arisen. Consider the way Marquis through its early maturity and other desirable qualities replaced Red Fife and allowed greatly expanded acreages of wheat. Subsequently varieties resistant to rust and most recently to sawfly damage have helped to consolidate the acreage.

Such developments have come over a period of 40 years. Breeding work and cultural studies with the sunflowers as a seed crop commenced in Western Canada only 10 years ago. The varieties Sunrise and Advance have already come from this work. Much has also been learned about cultural practices. The experience of scientific workers in the past can be directly applied to sunflowers. A firmly established Experimental Farms system now exists and a far larger number of trained workers are available than there were 20 to 30 years ago. These facts speak well for the possibility of a "Marquis" in sunflowers in the future and prompt action against pests and problems as they arise.

Well integrated extension services exist for the dissemination of new information and recognition of problems. Further, educational standards are at the highest level ever and continue to rise. People are continually becoming more willing to accept new ideas and information as they develop.

Considering then the favorable position of the sunflower as a cash crop, the contribution it can make to more stable local economy through better nutrition of livestock, through relief from a one-crop system and through development of local industry and the fact that a large number of trained workers are available, with the experience of past workers to draw from in the production phase, there should be no doubt that the sunflower has a permanent future in the economy of Western Canada.

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The Result of Community Effort

Plant as it looked in early 1947.

Fall of 1948, showing partially completed elevator. Pres-to-log building and annex are hidden behind elevators.